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VERIFIED TRANSLATION OF PRIORITY DOCUMENT

The undersigned, of the below address, hereby certifies that he/she well knows both the English and Japanese languages, and that the attached is an accurate translation into the English language of the Certified Copy, filed for this application under 35 U.S.C. Section 119 and/or 365, of:

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[Designation of Document] SPECIFICATION

[Title of the Invention] REFRIGERANT CYCLE APPARATUS

[Claimed Scope for Patent]

[Claim 1] A refrigerant cycle apparatus comprising

a compressor (1), a radiator (2), an ejector (3) and a gas-liquid separator (4) which are circularly connected by a refrigerant passage (A), wherein a liquid-phase refrigerant side of the gas-liquid separator (4) and a suction port (32) of the ejector (3) are connected by a refrigerant passage (C), and an evaporator (6) is disposed in the refrigerant passage (C), the refrigerant cycle apparatus being characterized in that:

a bypass passage (B) through which a part of a refrigerant flowing from the radiator (2) flows from an upstream of a high-pressure inlet portion (31a) of the ejector (3) into the refrigerant passage (C) between the evaporator (6) and the suction port (32) is provided; a control valve (7, 9 and 70) is disposed in the bypass passage (B); and when the refrigerant flowing from the radiator (2) meets a predetermined pressure condition, the control valve (7, 9, and 70) opens so that the refrigerant flows into the bypass passage (B).

[Claim 2] The refrigerant cycle apparatus according to claim 1, wherein,

the control valve (7) forms a part of the refrigerant passage (A) extended from the radiator (2) to the ejector (3), has a valve port (76) through which the refrigerant passage (A) communicates with the bypass passage (B), and forms a seal space (79) sealed with a gas refrigerant by a predetermined density within the

refrigerant passage (A),

the control valve includes a displacement member (72) which is moved in accordance with a pressure difference between an inside pressure of the seal space (79) and an outside pressure of the seal space (79), and a valve body (71) for switching the valve port (76) in accordance with a movement of the displacement member (72), and

when a pressure in the refrigerant passage (A) is higher than the pressure in the seal space (79), the displacement member (72) is displaced to open the valve port (76).

[Claim 3] The refrigerant cycle apparatus according to claim 1, wherein the control valve (9) is set to be opened when a refrigerant pressure from the radiator (2) that is upstream from the valve is larger than a refrigerant pressure at the outlet of the evaporator (6) that is downstream from the valve, by a predetermined pressure difference.

[Claim 4] The refrigerant cycle apparatus according to claim 1, further comprising:

an inner heat exchanger (8) for heat-exchanging between a refrigerant to be sucked to the compressor (1) and a refrigerant flowing from the radiator (2), wherein,

the control valve (70) forms a part of the refrigerant passage (A) extended from the radiator (2) to the ejector (3), has a valve port (76) through which the bypass passage (B) communicates with the refrigerant passage (A), and forms a seal space (79) where a refrigerant gas is sealed by a predetermined density in the refrigerant passage (A),

the control valve includes a displacement member (72) that is displaced in accordance with a pressure difference between an outside of the seal space (79) and an inside of the seal space (79), and a valve body (71) for switching the valve port (76) in accordance with a movement of the displacement member (72), and

when a pressure in a passage (A1) of the refrigerant passage (A), for supplying refrigerant to the inner heat exchanger (8), is larger than an inner pressure in the seal space (79), the displacement member (72) is displaced, so that the valve port (76) is opened in a passage (A2) of the refrigerant passage (A), for discharging refrigerant from the inner heat exchanger (8).

[Claim 5] The refrigerant cycle apparatus according to any one of claims 1 to 4, wherein the control valve (7, 9 and 70) and the ejector (3) are integrated.

[Claim 6] The refrigerant cycle apparatus according to any one of claims 1 to 5, further comprising

a check valve (10) for preventing the refrigerant from reversely flowing is disposed at an optional position between a liquid refrigerant outlet of the gas-liquid separator (4) and a join portion (G) downstream of the bypass passage (B) in the refrigerant passage(C).

[Claim 7] The refrigerant cycle apparatus according to any one of claims 1 to 5, further comprising

a switching valve (11) for enabling to shut a refrigerant flow, disposed between the ejector (3) and the gas-liquid separator (4).

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a refrigerant cycle (a refrigerant cycle with an ejector) apparatus using an ejector
5 for performing pressurization of refrigerant utilizing expansion energy of the refrigerant.

[0002]

[Background of the Invention]

As a conventional refrigerant cycle, it has been known a
10 way using an ejector. For example, JP-A-6-2964 shows a refrigerant cycle which performs circulation and pressurization of low-pressure refrigerant passing through an evaporator, utilizing expansion energy of refrigerant by an ejector, and improves cycle efficiency in comparison with a common refrigerant
15 cycle without an ejector.

[0003]

FIG. 13 is a schematic diagram showing a refrigerant cycle with an ejector in a prior art. 1 is a compressor for compressing and pressurizing refrigerant, 2 is a radiator for cooling
20 high-pressure refrigerant, 3 is an ejector, 4 is a gas-liquid separator, 5 is a flow control valve and 6 is an evaporator. Further, Fig. 14 is a cross-sectional view showing the ejector 3. The ejector 3 is constructed with a nozzle 31, a low-pressure suction port 32, a mixing portion 33 and a diffuser 34, and 31a is a
25 high-pressure inlet portion and 35 is an outlet port.

[0004]

An operation of the ejector 3 will be described referring to Fig. 14. High-pressure refrigerant flows into the nozzle 31 from the high-pressure inlet portion 31a and is decompressed by nozzle 31, and converting expansion energy of the refrigerant into kinetic energy of the refrigerant, the flow velocity is increased, and the refrigerant is injected from the tip 31c of the nozzle as a gas-liquid two-phase state high-speed jet. On the other hand, low-pressure refrigerant flowing from the evaporator 6 is sucked into the ejector 3 from the low-pressure inlet portion 32, utilizing the pressure drop around the nozzle jet.

[0005]

The sucked low-pressure refrigerant and the nozzle jet are mixed in the mixing portion 33 of the ejector 3. At this timing, kinetic momentum is exchanged while the high-speed nozzle jet and the low-speed low-pressure refrigerant is mixing together. The refrigerant is discharged from the ejector outlet port 35 via the diffuser 34, which decelerates the mixed refrigerant and converts kinetic energy into pressure energy. Through this process, the low-pressure refrigerant is pressurized higher than the low-pressure inlet portion 32 side, by expansion energy of the high-pressure refrigerant.

[0006]

[Problem to be solved by this invention]

In this ejector 3, because a sectional area of a throat portion 31b whose cross-sectional area of the flow path is the smallest in the nozzle 31 is fixed, a flow amount of refrigerant cannot

be adjusted in accordance with an operation condition of the refrigerant cycle. In a refrigerant cycle with a small load fluctuation, it is possible to operate the refrigerant cycle, designing the sectional area of the throat portion 31b in response to a constant condition where the refrigerant cycle frequently operates.

[0007]

However, in case of using for a vehicle air conditioner or the like, as the compressor 1 is driven by an engine which is not shown, a rotational speed of the compressor 1 is largely changed and also a flow amount of the refrigerant is largely changed. Accordingly, in a case where the sectional area of the throat portion 31b is determined with the similar way of designing described above, the refrigerant pressure may be increased at the time when the refrigerant flow amount increases, and the efficiency of the refrigerant cycle may be deteriorated as consumed power of the compressor 1 may increase. Besides, the refrigerant pressure may be excessively increased so that the continuance of the operation may be difficult.

[0008]

Especially, in a refrigerant cycle using carbon dioxide as the refrigerant for de-Freon, since the high-pressure side operates at about 10 times pressure than a conventional Freon and is a supercritical cycle wherein refrigerant does not condense even in a high-pressure, the pressure change amount is larger than that in Freon to the same change rate of the refrigerant flow amount. Besides, as the pressure is apt to change rapidly,

it is difficult to stably operate the refrigerant cycle.

[0009]

5 Additionally, in an air conditioner for an electric vehicle with an electric compressor or an air conditioner for home use, it may need a large flow amount of the refrigerant because large cooling capacity is needed at a cool down or the like, and a problem similar to the vehicle air conditioner may be caused. In view of the foregoing problems, it is an object to provide a refrigerant cycle apparatus, which prevents a refrigerant pressure from being
10 increased due to the increase of the refrigerant flow amount and improves cooling capacity in accordance with the increase of the refrigerant flow amount.

[0010]

[Means for solving the problem]

To achieve the above object, technical means described in claim 1 through 7 are adopted in the present invention. According to claim 1, a refrigerant cycle apparatus comprising:

a compressor (1), a radiator (2), an ejector (3) and a gas-liquid separator (4) are circularly connected by a refrigerant passage (A), and a liquid-phase refrigerant side of the gas-liquid separator (4) and a suction port (32) of the ejector (3) are connected by a refrigerant passage (C), and an evaporator (6) is disposed in the passage (C), wherein:

a bypass passage (B) through which a part of a refrigerant flowing from the radiator (2) flows from an upstream of a high-pressure inlet portion (31a) of the ejector (3) into the refrigerant passage (C) between the evaporator (6) and the suction

port (32) is provided, and a control valve (7, 9 and 70) is disposed in the bypass passage (B), and when the refrigerant flowing from the radiator (2) meets a predetermined pressure condition, the control valve (7, 9, and 70) opens so that the refrigerant flows into the bypass passage (B).

[0011]

That is, when the flow amount of the refrigerant increases and the pressure of the high-pressure refrigerant is increased more than a necessary pressure, a part of high-pressure refrigerant is branched and bypassed to flow into the suction side of the ejector (3) to prevent the pressure of high-pressure refrigerant from being increased. Therefore, it can prevent the pressure of high-pressure refrigerant from being excessively increased, and the refrigerant cycle operates stably. Besides, it can restrict the consumed power of the compressor (1) from being increased even when the refrigerant flow amount increases, and the efficiency of the refrigerant cycle can be improved.

[0012]

Further, liquid refrigerant passing through the bypass passage (B) is mixed with liquid refrigerant sucked into the ejector (3) and jetted from the nozzle (31). Thereafter, the mixed refrigerant flows from the gas-liquid separator (4) to the evaporator (6) and performs an effect as an air conditioner. Accordingly, flowing refrigerant to the bypass passage (B) in case a large cooling capacity is needed at a cool-down or the like, it is possible to supply a large amount of liquid refrigerant to the evaporator (6) in comparison with a conventional refrigerant,

and cooling capacity can be sufficiently obtained.

[0013]

According to claim 2, the control valve (7) forms a part of the refrigerant passage (A) extended from the radiator (2) to the ejector (3), and has a valve port (76) through which the refrigerant passage (A) communicates with the bypass passage (B), and forms a seal space (79) sealed with a gas refrigerant by a predetermined density within the refrigerant passage (A), and comprises a displacement member (72) which is moved in accordance with a pressure difference between an inside pressure of the seal space (79) and an outside pressure of the seal space (79), and a valve body (71) for switching the valve port (76) in accordance with a movement of the displacement member (72), wherein when a pressure in the refrigerant passage (A) is higher than the pressure in the seal space (79), the displacement member (72) is displaced to open the valve port (76).

[0014]

Accordingly, when the pressure of high-pressure refrigerant in the high-pressure refrigerant passage (A) is lower than the inside pressure of the seal space (79) as a predetermined pressure, all of the refrigerant flowing from the radiator (2) passes through the ejector (3). On the other hand, when the pressure of high-pressure refrigerant in the high-pressure refrigerant passage (A) is higher than the inside pressure of the seal space (79) as the predetermined pressure, a part of the high-pressure refrigerant passes through the bypass passage (B). Accordingly, it can prevent the pressure of high-pressure refrigerant from

being excessively increased due to increase of the refrigerant flow amount.

[0015]

Further, because the inside pressure of the seal space (79) in the control valve (7) changes in accordance with the temperature of the high-pressure refrigerant flowing from the radiator (2), the valve-opening pressure of the control valve (7) also changes in accordance with the temperature of the high-pressure refrigerant. Accordingly, the valve-opening pressure approximately corresponds to the optimum control line, which maximizes COP (coefficient of performance of refrigerant cycle). Therefore, the operation of the refrigerant cycle can be controlled to a high COP condition.

[0016]

According to claim 3, the control valve (9) is set to be opened when a refrigerant pressure from the radiator (2) that is upstream from the valve is larger than a refrigerant pressure at the outlet of the evaporator (6) that is downstream from the valve, by a predetermined pressure difference.

[0017]

The control valve (9) of the present invention is a differential pressure valve (9), which opens when the differential pressure between front and rear of the valve is larger than a predetermined value. Because the differential pressure valve (9) is used, it is possible to control so that the pressure of refrigerant bypassing the ejector (3) becomes higher as the cooling load is large and the pressure in the evaporator (6) becomes higher,

and as the cooling load is smaller and the pressure inside the evaporator (6) becomes lower, the pressure of refrigerant bypassing the ejector (3) becomes lower.

[0018]

5 In a case of a CO₂ cycle where carbon dioxide is used as refrigerant, when the refrigerant temperature at the outlet of the radiator (2) is the same, the enthalpy difference used for cooling becomes larger as the refrigerant pressure becomes higher. Therefore, when the cooling load is large, the valve-opening
10 pressure to open the differential pressure valve (9) becomes larger, and the cooling capacity is increased. On the other hand, when the cooling load is small, the valve-opening pressure to open the differential pressure valve (9) becomes smaller, and the cooling capacity is reduced. Accordingly, the increase of the
15 consumed power of the compressor (1) is held down, and the decrease of the COP of the refrigerant cycle is also held down.

[0019]

 According to claim 4, in the refrigerant cycle, an inner heat exchanger (8) for heat-exchanging between a refrigerant to
20 be sucked to the compressor (1) and a refrigerant flowing from the radiator (2) is provided, and the control valve (70) forms a part of the refrigerant passage (A) extended from the radiator (2) to the ejector (3), and has a valve port (76) through which the bypass passage (B) communicates with the refrigerant passage
25 (A), and forms a seal space (79) where a refrigerant gas is sealed by a predetermined density in the refrigerant passage (A), and includes a displacement member (72) that is displaced in accordance

with a pressure difference between an outside of the seal space (79) and an inside of the seal space (79), and a valve body (71) for switching the valve port (76) in accordance with a movement of the displacement member (72), wherein when a pressure in a passage (A1) of the refrigerant passage (A), for supplying refrigerant to the inner heat exchanger (8), is larger than an inner pressure in the seal space (79), the displacement member (72) is displaced, so that the valve port (76) is opened in a passage (A2) of the refrigerant passage (A), for discharging refrigerant from the inner heat exchanger (8).

[0020]

In this manner, the present invention can be effectively used for the refrigerant cycle having the inner heat exchanger (8) and improves the cooling capacity. The advantages of this invention are similarly to those of claim 2. That is, when the pressure in the high-pressure refrigerant passage (A1) is equal to or lower than the pressure of the seal space (79) as a predetermined pressure, the entire refrigerant from the radiator (2) passes through the ejector (3). On the other hand, when the pressure in the high-pressure refrigerant passage (A1) is higher than the pressure of the seal space (79) as the predetermined pressure, a part of the high-pressure refrigerant flows into the bypass passage (B). Therefore, it can prevent the pressure from being excessively increased due to the increase of the refrigerant flow amount.

[0021]

Further, because the inner pressure of the seal space (79)

changes in accordance with the temperature of the high-pressure refrigerant flowing from the radiator (2), the valve-opening pressure of the control valve (70) also changes in accordance with the temperature of the high-pressure refrigerant. Further, because the valve-opening pressure approximately corresponds to the optimum control line which maximize the COP (coefficient of performance of the refrigerant cycle), the control valve (70) in this embodiment can control the operation of the refrigerant cycle to a high COP condition.

[0022]

According to claim 5, the control valve (7, 9 and 70) and the ejector (3) are integrated. Accordingly, a number of the parts is reduced as a whole, and the process and assemble can be easily. Additionally, because the apparatus can be downsized and the passage like a pipe of the bypass passage (B), connecting between components can be reduced, performance of mounting on a vehicle and assembling can be improved.

[0023]

According to claim 6, in the refrigerant cycle, a check valve (10) for preventing from reversely flowing is disposed at an optional position between a liquid refrigerant outlet of the gas-liquid separator (4) and a join portion (G) downstream of the bypass passage (B) in the refrigerant passage (C). In this manner, it can prevent refrigerant after passing through the bypass passage (B) from being reversely flowing toward the evaporator (6), thereby preventing the refrigerant circulation from staying.

[0024]

According to claim 7, in the refrigerant cycle, a switching valve (11) for enabling to shut a refrigerant flow, is disposed between the ejector (3) and the gas-liquid separator (4). In the invention according to claim 1 though claim 6, it is premised on
5 flowing refrigerant from the gas-liquid separator (4) to the ejector (3) through the evaporator (6). According to claim 7, however, the switching valve (11) is provided at the outlet side of the ejector (3), and the switching valve (11) is closed at the same time as the opening time of the control valve (7, 9 and 70).
10 Accordingly, refrigerant from the bypass passage (B) flows from the evaporator (6) into the gas-liquid separator (4).

[0025]

In this case, refrigerant circulates similarly to a general expansion-valve cycle. Accordingly, as it is possible to supply
15 refrigerant flowing from the bypass passage (B) to the evaporator (6) directly, it can prevent the refrigerant pressure from being excessively increased due to the ejector (3) and improve the cooling capacity. Numbers in bracket in the means described above show relationship with methods in embodiments described later.

20 [0026]

[Embodiment of the Present Invention]

[First Embodiment]

Embodiments of the present invention will be described hereinafter
25 with reference to the appended drawings. FIG. 1 is a schematic diagram showing a refrigerant cycle with an ejector according to a first embodiment of the present invention. Carbon dioxide

(CO₂) is used as refrigerant.

[0027]

1 is a compressor for compressing refrigerant from low-pressure to high-pressure, 2 is a radiator for radiating heat from high-pressure refrigerant, 3 is an ejector for performing circulation and pressurization of low-pressure refrigerant utilizing expansion energy of the refrigerant, 4 is a gas-liquid separator for separating gas-liquid two-phase refrigerant discharged from the ejector 3 into gas refrigerant and liquid refrigerant, and sending the gas refrigerant to the compressor 1 and the liquid refrigerant for the evaporator 6 side, 5 is a flow control valve for adjusting refrigerant flow amount, and 6 is the evaporator for evaporating refrigerant and absorbing heat. As the flow control valve 5, a super-heating degree control valve or a fixed throttle can be used.

[0028]

A fan, which is not shown, is provided to the radiator 2 and the evaporator 6 and blows air, respectively. A branch is provided in a refrigerant passage A coupling the radiator 2 and the ejector 3. A control valve 7 controls bifurcation of refrigerant there. A bypass passage B through which the control valve 7 communicates with a refrigerant passage C, which is between evaporator 6 and the suction port 32 of the ejector 3, is provided.

[0029]

FIG. 2 is a cross-sectional view showing the control valve 7 applied for this refrigerant cycle with an ejector. This structure is similar to the control valve described in

JP-A-9-264622 filed by the applicant prior to this application. The control valve 7 includes a valve body 71 and a diaphragm 72 connected to the valve body 71. The diaphragm 72 is inserted between an upper case 73 and a lower case 74, and those are welded at a peripheral portion 75. A valve port 76 is provided to communicate with the bypass passage B. The valve body 71 moves vertically in accordance with a displacement of the diaphragm 72 so as to open and close the bypass passage B between the valve body 71 and the valve port 76.

[0030]

A seal space 79 is defined by the upper case 73 and the diaphragm 72. Carbon dioxide is sealingly stored in the seal space 79, so that the carbon dioxide sealed in the seal space 79 has a density of about 600 Kg/m³ when the valve body 71 closes. 80 is a sealing port from which carbon dioxide is introduced, and is sealed by a sealing member 81 by welding or brazing. High-pressure refrigerant flowing from the radiator 2 toward the ejector 3 flows around the upper case 73 and the lower case 74. The temperature in the seal space 79 is approximately equal to the temperature of the high-pressure refrigerant around.

[0031]

In the first embodiment, after the upper case 73, the diaphragm 72 and the lower case 74 are welded, the welded member is fixed to a stay 83 provided in a housing 82 by screwing, welding or the like and a fastening member 84 is used for the fixing. 85 is a refrigerant passage toward the lower case 74 side. A rod 77 is connected to the valve body 71, and applies a force toward

a valve-closing direction by helical compression spring 78.

[0032]

When the refrigerant pressure becomes equal to or lower than the critical pressure and high-pressure side refrigerant flows in a gas-liquid two-phase state, the temperature inside the seal space 79 becomes equal to the high-pressure side refrigerant temperature around, and the pressure inside the seal space 79 (a saturation pressure at the temperature) becomes equal to the high-pressure side refrigerant. Therefore, force for closing the valve does not work and refrigerant does not flow through the bypass passage B and the control valve opens at a time when supercooling degree of refrigerant becomes a predetermined value. The spring force is set at about 0.6 MPa (a pressure corresponding to supercooling degree approximately 5 °C at opening timing when high-side refrigerant pressure is equal to or less than critical pressure) when being calculated by the pressure in the diaphragm 72.

[0033]

Operation of the control valve 7 will be described. Because carbon dioxide is sealed in the seal space 79 by about 600 kg/m³, the inside pressure of the seal space 79 and the temperature change along the isodensity line of 600 kg/m³ as indicated in the Mollier diagram of carbon dioxide in FIG. 3.

[0034]

When the temperature inside the seal space 79 is 40 °C, the inside pressure is about 9.7 MPa. Accordingly, when the pressure of the high-pressure refrigerant is lower than 10.3 MPa that is

the total pressure of the inside pressure of the seal space 79 and the pressure due to the spring force, because the total pressure of the inside pressure of the seal space 79 and the pressure due to the spring force is greater, the diaphragm 72 is pushed downward in the figure, and the valve body 71 closes the valve port 76 so that refrigerant does not flows through the bypass passage B. Conversely, when the pressure of the high-pressure refrigerant is higher than 10.3 Mpa, the valve opens so that refrigerant flows through the bypass passage B.

[0035]

Next, the operation of the refrigerant cycle will be described. When the flow amount of refrigerant is small and the pressure of the high-pressure refrigerant is lower than the valve-opening pressure of the control valve 7, the control valve 7 is closed so that all refrigerant passes through the ejector 3 and performs the same operation as a conventional refrigerant cycle with an ejector.

[0036]

On the other hand, when the flow amount of the refrigerant increases and the pressure of the high-pressure refrigerant becomes higher than the valve-opening pressure of the control valve 7, the control valve 7 opens so that a part of the refrigerant flowing from the radiator 2 flows into the refrigerant passage C between the evaporator 6 and the suction port 32 of the ejector 3 via the bypass passage B after being decompressed in the control valve 7. Refrigerant flowing into the refrigerant passage C is mixed with the refrigerant flowing from the evaporator 6, and

the mixed refrigerant is sucked into the ejector 3.

[0037]

Next, features in this embodiment will be described. As described above, the bypass passage B through which a part of the refrigerant from the radiator 2 flows from an upstream portion that is upstream of the high-pressure inlet portion 31a of the ejector 3 to the refrigerant passage C between the evaporator 6 and the suction port 32 is provided, and the control valve 7 is provided in the bypass passage B such that the control valve 7 is opened when refrigerant flowing from the radiator 2 meets the predetermined pressure condition so that refrigerant flows into the bypass passage B.

[0038]

That is, when the refrigerant flow amount increases and the pressure of the high-pressure refrigerant is increased more than a necessary pressure, a part of high-pressure refrigerant is branched and bypassed to flow into the suction side of the ejector 3 to prevent the pressure of high-pressure refrigerant from being increased. Therefore, it can prevent the pressure of high-pressure refrigerant from being excessively increased, and the refrigerant cycle operates stably. Besides, it can restrict the consumed power of the compressor 1 from being increased even when the refrigerant flow amount increases, and the efficiency of the refrigerant cycle can be improved.

[0039]

Further, liquid refrigerant passing through the bypass passage B is mixed with liquid refrigerant sucked into the ejector

3 and jetted from the nozzle 31. Thereafter, the mixed refrigerant flows from the gas-liquid separator 4 to the evaporator 6 and performs an effect as an air conditioner. Accordingly, flowing refrigerant to the bypass passage B in case a large cooling capacity is needed at a cool-down operation or the like, it is possible to supply a large amount of liquid refrigerant to the evaporator 6 in comparison with a conventional refrigerant, and cooling capacity can be sufficiently obtained in the evaporator 6.

[0040]

Additionally, the control valve 7 forms a part of the high-pressure refrigerant passage A from the radiator 2 to the ejector 3, and has the valve port 76 which makes the refrigerant passage A communicate with the bypass passage B, and forms the seal space 79 sealed with the gas refrigerant by a predetermined density within the refrigerant passage A. The control valve 7 has the displacement member 72 which is moved in accordance with a pressure difference between the inside pressure of the seal space 79 and the outside pressure of the seal space 79, and the valve body 71 to open and close the valve port 76 in accordance with the movement of the diaphragm 72. Further, when the pressure in the refrigerant passage A is higher than the pressure in the seal space 79 as a predetermined pressure, the displacement member 72 moves to open the valve port 76.

[0041]

Accordingly, when the pressure of high-pressure refrigerant in the high-pressure refrigerant passage A is equal to or lower than the inside pressure of the seal space 79 as the predetermined

pressure, all of the refrigerant flowing from the radiator 2 passes through the ejector 3. On the other hand, when the pressure of high-pressure refrigerant in the high-pressure refrigerant passage A is higher than the inside pressure of the seal space 79 as the predetermined pressure, a part of the refrigerant passes through the bypass passage B. Accordingly, it can prevent the pressure of high-pressure refrigerant from being excessively increased due to increase of the refrigerant flow amount.

[0042]

Further, because the inside pressure of the seal space 79 in the control valve 7 changes in accordance with the temperature of the high-pressure refrigerant flowing from the radiator 2, the valve-opening pressure of the control valve 7 also changes in accordance with the temperature of the high-pressure refrigerant. Accordingly, the valve-opening pressure approximately corresponds to the optimum control line, which maximizes COP (coefficient of performance of refrigerant cycle). Therefore, the operation of the refrigerant cycle can be controlled to a high COP condition.

[0043]

[Second Embodiment]

FIG. 4 is a schematic diagram showing a refrigerant cycle with an ejector according to a second embodiment of the present invention. Only a structure of a control valve 9 is different from that of the first embodiment. FIG. 5 is a cross-sectional view showing a control valve (differential pressure valve) 9 applied to the refrigerant cycle with an ejector in this embodiment.

91 is a housing made of a metal such as a stainless steel and a brass. An inlet 92 communicates with a branch point F that is provided in the refrigerant passage A for connecting the radiator 2 and the ejector 3, and an outlet 95 communicates with the bypass passage C between evaporator 6 and the suction port 32 of the ejector 3 and forms a part of the bypass passage B.

[0044]

In the housing 91, a valve port 93 through which a space of the inlet 92 side communicates with a space of the outlet 95 side is formed. Further, in a space of the outlet 95 side, a valve body 96 is provided for adjusting an opening degree of the valve port 93. The valve body 96 is pressed by a coil spring (elastic member) 97 made of a metal toward the valve port 93.

[0045]

The housing 91 includes three portions of a bottom portion having the inlet 92, a cylindrical body portion and a cover member 94 having the outlet 95. The bottom portion and the cylindrical body portion are integrally formed. After the valve body 96 and the coil spring 97 are disposed in the housing 91, the cover member 94 is connected to the housing 91 by fastening such as welding and screwing.

[0046]

Additionally, 98 is a guide skirt for guiding the movement of the valve body 96 in the housing 91 and as a cylindrical outer surface of the guide skirt 98 contacts an inner wall surface of the housing 91, the movement of the valve body 96 is guided. Plural holes 99 as a passage of carbon dioxide are formed in the guide

skirt 98 at positions near the valve body 96.

[0047]

Next, the operation of the differential pressure valve 9 will be described. As shown in FIG. 5, an operation force F1 is applied to the inlet 92 side of the valve body 96 due to the pressure at the outlet side from the radiator 2, so as to press the valve body 96 toward the outlet 95 side. On the other hand, an operation force F2 due to the pressure at the outlet side of the evaporator 6 and the elastic force of the coil spring 97 is applied to the outlet 95 side, so as to press the valve body 96 toward the inlet 92 side.

[0048]

That is, when the operation force F2 is larger than the operation force F1, the valve port 93 is closed by the valve body 96, and refrigerant does not flows through the bypass passage B. On the other hand, when the operation force F2 is equal to or smaller than the operation force F1, the valve body 96 is pushed by the operation force F1 and move to open the valve port 93, and refrigerant flows through the bypass passage B. Accordingly, the valve open differential pressure ΔP of the differential pressure valve 9 corresponds to the elastic force of the coil spring 97 applied to the valve body 96.

[0049]

For example, FIG. 6 is a graph showing operation characteristics of the differential pressure valve 9, and the relationship is, when the cooling load is large and the pressure at the outlet side of the evaporator 6 is high, the valve-opening

pressure of the differential pressure valve 9 is also high, and when the cooling load is small and the pressure at the outlet side of the evaporator 6 is low, the valve-opening pressure of the differential pressure valve 9 is also low.

5 [0050]

Next, the features of this embodiment will be described. The control valve 9 of the present invention is set to be opened when the refrigerant pressure from the radiator 2 that is upstream from the valve is larger than the refrigerant pressure at the outlet of the evaporator 6 that is downstream from the valve, by a predetermined pressure difference. That is, the control valve 9 is a differential pressure valve 9 which opens when the differential pressure between front and rear of the valve is larger than a predetermined value. Because the differential pressure valve 9 is used, it is possible to control so that the pressure of refrigerant bypassing the ejector 3 becomes higher as the cooling load is large and the pressure in the evaporator 6 becomes higher, and as the cooling load is smaller and the pressure inside the evaporator 6 becomes lower, the pressure of refrigerant bypassing the ejector 3 becomes lower.

[0051]

In a case of a CO₂ cycle where carbon dioxide is used as the refrigerant, when the refrigerant temperature at the outlet of the radiator 2 is the same, the enthalpy difference used for cooling becomes larger as the refrigerant pressure becomes higher. Therefore, when the cooling load is large, the valve-opening pressure to open the differential pressure valve 9 becomes larger,

and the cooling capacity is increased. On the other hand, when the cooling load is small, the valve-opening pressure to open the differential pressure valve 9 becomes smaller, and the cooling capacity is reduced. Accordingly, the increase of the consumed power of the compressor 1 is held down, and the decrease of the COP of the refrigerant cycle is also held down.

[0052]

[Third Embodiment]

FIG. 7 is a schematic diagram showing a refrigerant cycle with an ejector according to a third embodiment of the present invention. In this embodiment, an inner heat exchanger 8 for performing heat exchange between refrigerant to be sucked to the compressor 1 and refrigerant flowing from the radiator 2 is added.

[0053]

The inner heat exchanger 8 is formed by brazing pressed aluminum plates so that a passage 8a through which refrigerant to be sucked into the compressor 1 and a passage 8b through which refrigerant flowing from the radiator 2 flows in opposition to each other, and used as a means for improving the cooling capacity and the COP.

[0054]

FIG. 8 is a cross-sectional view showing a control valve 70 used for the refrigerant cycle with an ejector in this embodiment. To make a temperature sensing portion (the seal space 79 surrounded by the diaphragm 72 and an upper case 73) of the control valve 70 sense a refrigerant temperature flowing from the radiator 2, a partition wall 86 is disposed for partitioning into a refrigerant

passage A1 on the upper case 73 and a refrigerant passage A2→
A3 on the side of the valve body 71, and an insulation layer 87
made of resin is provided on an outer surface of the lower cover
74 for restricting heat from refrigerant A2 after passing through
5 the inner heat exchanger 7 from being transmitted to the diaphragm
72 side.

[0055]

Next, operation of the refrigerant cycle will be described.
Refrigerant flowing from the radiator 2 passes through the
10 refrigerant passage A1 of the control valve 70, and is cooled
in the inner heat exchanger 8 by low-temperature refrigerant to
be sucked to the compressor 1 and the temperature decreases.
Thereafter, the refrigerant passes through the control valve 70
from the refrigerant passage A2 to the refrigerant passage A3,
15 and flows into the ejector 3. The operation of the control valve
70 is the same to the operation of the control valve 7 described
in the first embodiment. That is, when the pressure of the
refrigerant at the high-pressure side is higher than the
valve-opening pressure of the control valve 70, the valve is opened
20 so that refrigerant flows into the bypass passage B. On the other
hand, when the pressure of the refrigerant at the high-pressure
side is equal to or lower than the valve-opening pressure, the
valve is closed.

[0056]

25 Next, the features of this embodiment will be described.
In the refrigerant cycle apparatus, the inner heat exchanger 8,
where the refrigerant to be sucked to the compressor 1 is

heat-exchanged with refrigerant flowing from the radiator 2, is provided. Further, the control valve 70 forms a part of the refrigerant passage A from the radiator 2 to the ejector 3, and has the valve port 76 through which the bypass passage B communicates with the refrigerant passage A, and forms the seal space 79 where the refrigerant gas is sealed by a predetermined density in the refrigerant passage A. In addition, the control valve 70 includes the diaphragm 72 that is displaced in accordance with the pressure difference between outside and inside of the seal space 79, and the valve body 71 is moved with the displacement of the diaphragm 72 to open and close the valve port 76.

[0057]

Accordingly, when the pressure in the refrigerant passage A1 of the refrigerant passage A, for supplying refrigerant to the inner heat exchanger 8, is larger than the inner pressure in the seal space 79, the diaphragm 72 is displaced, so that the valve port 76 is opened in the passage A2 of the refrigerant passage A, for discharging refrigerant from the inner heat exchanger 8.

[0058]

In this manner, the present invention can be effectively used for the refrigerant cycle having the inner heat exchanger 8 and improves the cooling capacity.

The advantages of this embodiment are similarly to the first embodiment. That is, when the pressure in the high-pressure refrigerant passage A1 is equal to or lower than the pressure of the seal space 79 as a predetermined pressure, the entire refrigerant from the radiator 2 passes through the ejector 3.

On the other hand, when the pressure in the high-pressure refrigerant passage A1 is higher than the pressure of the seal space 79 as a predetermined pressure, a part of the high-pressure refrigerant flows into the bypass passage B. Therefore, it can prevent the pressure from being excessively increased due to the increase of the refrigerant flow amount.

[0059]

Further, because the inner pressure of the seal space 79 changes in accordance with the temperature of the high-pressure refrigerant flowing from the radiator 2, the valve-opening pressure of the control valve 70 also changes in accordance with the temperature of the high-pressure refrigerant, and because the valve-opening pressure approximately corresponds to the optimum control line which maximize the COP (coefficient of performance the efficiency), the control valve 70 in this embodiment can control the operation of the refrigerant cycle to a high COP condition.

[0060]

[Fourth Embodiment]

FIG. 9 is a cross-sectional view showing an integrated structure of an ejector 3 and a control valve 7, and FIG. 10 is a cross-sectional view showing an integrated structure of an ejector 3 and a differential pressure valve 9. In this embodiment, the control valve 7 or differential pressure valve 9 is integrated with the ejector 3, and thereby, the bypass passage B is unnecessary. The control valve 7 in Fig. 9 may be the control valve 70 shown in Fig. 8. The structure and operation of the control valve 7, 70

and the differential pressure valve 9 are similar to those of the above-described embodiments.

[0061]

Accordingly, as a number of the parts is reduced as a whole,
5 the process and assemble can be easily. Additionally, because the apparatus can be downsized and the passage, such like a pipe of the bypass passage, connecting between instruments B can be reduced, performance of mounting on a vehicle and assembling can be improved.

10 [0062]

[Fifth Embodiment]

FIG. 11 is a schematic diagram showing a refrigerant cycle with an ejector according to a fifth embodiment of the present invention. A check valve 10 for preventing from reversely flowing
15 is disposed at an optional position between the outlet of the gas-liquid separator 4 and a join portion G downstream of the bypass passage B in the refrigerant passage C, adding to the refrigerant cycle apparatus in the embodiments described above. Therefore, it can prevent refrigerant after passing through the
20 bypass passage B from being reversely flowing toward the evaporator 6, thereby preventing the refrigerant circulation from staying.

[0063]

[Sixth Embodiment]

FIG. 12 is a schematic diagram showing a refrigerant cycle
25 with an ejector according to a sixth embodiment of the present invention. To the refrigerant cycle apparatus in the embodiment described above, a switching valve 11 for enabling to shut a

refrigerant flow is disposed between the ejector 3 and the gas-liquid separator 4.

[0064]

5 In the refrigerant cycle apparatus in the embodiment described above, it is premised on flowing refrigerant from the gas-liquid separator 4 to the ejector 3 through the evaporator 6. In this embodiment, however, the switching valve 11 is provided at the outlet side of the ejector 3, and the switching valve 11 is closed at the same time as the opening time of the control valve 7, 9
10 and 70. Accordingly, refrigerant from the bypass passage B flows from the evaporator 6 into the gas-liquid separator 4.

[0065]

In this case, refrigerant circulates similarly to a general expansion-valve cycle. Because it is possible to supply
15 refrigerant flowing from the bypass passage B to the evaporator 6 directly, it can prevent the refrigerant pressure from being excessively increased due to the ejector 3 and improve the cooling capacity.

[0066]

20 [Other embodiments]

In the above-described embodiments, the refrigerant cycle using carbon dioxide as the refrigerant is described though, the present invention may be applied to the refrigerant cycle where Freon is used as the refrigerant. Further, in the above-described
25 embodiment, the control valve operates mechanically. However, as the control valve, an electrical valve such as an electrical expansion valve, which has been known since before, with a fully

closing function may be used.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1]

5 FIG. 1 is a schematic diagram showing a refrigerant cycle with an ejector according to a first embodiment of the present invention.

[FIG. 2]

10 FIG. 2 is a cross-sectional view showing a control valve used for the refrigerant cycle with an ejector according to the first embodiment.

[FIG. 3]

FIG. 3 is a Mollier diagram of carbon.

[FIG. 4]

15 FIG. 4 is a schematic diagram showing a refrigerant cycle with an ejector according to a second embodiment of the present invention.

[FIG. 5]

20 FIG. 5 is a cross-sectional view showing a differential pressure valve used for the refrigerant cycle with an ejector in FIG. 4.

[FIG. 6]

FIG. 6 is a graph showing a type of operation characteristics of a differential pressure valve.

25 [FIG. 7]

FIG. 7 is a schematic diagram showing a refrigerant cycle with an ejector according to a third embodiment of the present

invention.

[FIG. 8]

FIG. 8 is a cross-sectional view showing a control valve used for the refrigerant cycle with an ejector in FIG. 7.

5 [FIG. 9]

FIG. 9 is a cross-sectional view showing an integrated structure of an ejector and a control valve.

[FIG. 10]

10 FIG. 10 is a cross-sectional view showing an integrated structure of an ejector and a differential pressure valve.

[FIG. 11]

FIG. 11 is a schematic diagram showing a refrigerant cycle with an ejector according to a fourth embodiment of the present invention.

15 [FIG. 12]

FIG. 12 is a schematic diagram showing a refrigerant cycle with an ejector according to a fifth embodiment of the present invention.

[FIG. 13]

20 FIG. 13 is a schematic diagram showing a refrigerant cycle with an ejector in a prior art.

[FIG. 14]

FIG. 14 is a cross-sectional view showing an ejector.

[Reference Numerals]

25 1 compressor

2 radiator

3 ejector

- 4 gas-liquid separator
- 6 evaporator
- 7 control valve
- 8 inner heat exchanger
- 5 9 differential pressure valve (control valve)
- 10 check valve
- 11 switching valve
- 31a high-pressure inlet portion
- 32 suction port
- 10 70 control valve
- 71 valve body
- 72 diaphragm (displacement member)
- 76 valve port
- 79 seal space
- 15 A, A1, A2 and C refrigerant passage
- B bypass passage
- G joint portion

整理番号 = P S N 2 7 8

Designation of Document
【書類名】 図面 Drawings
FIG. 1
【図1】

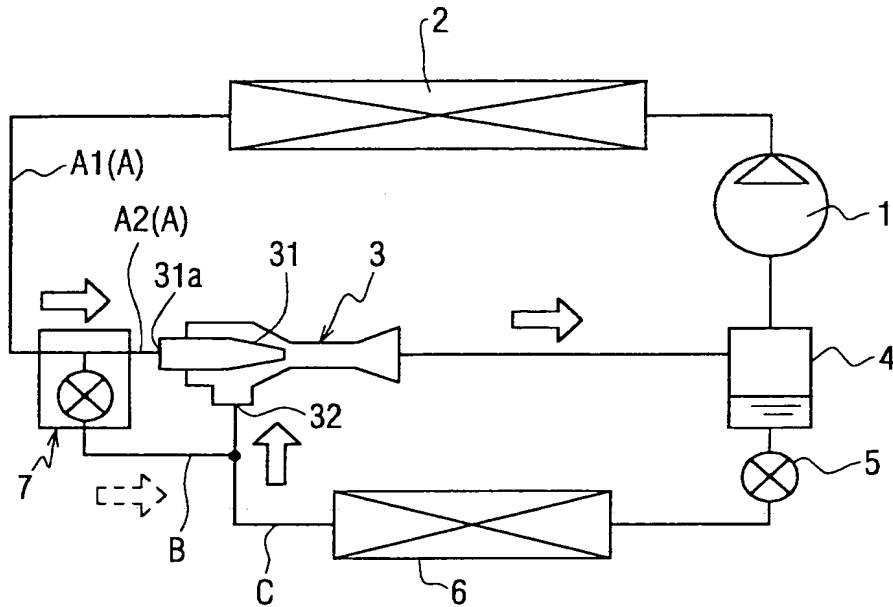
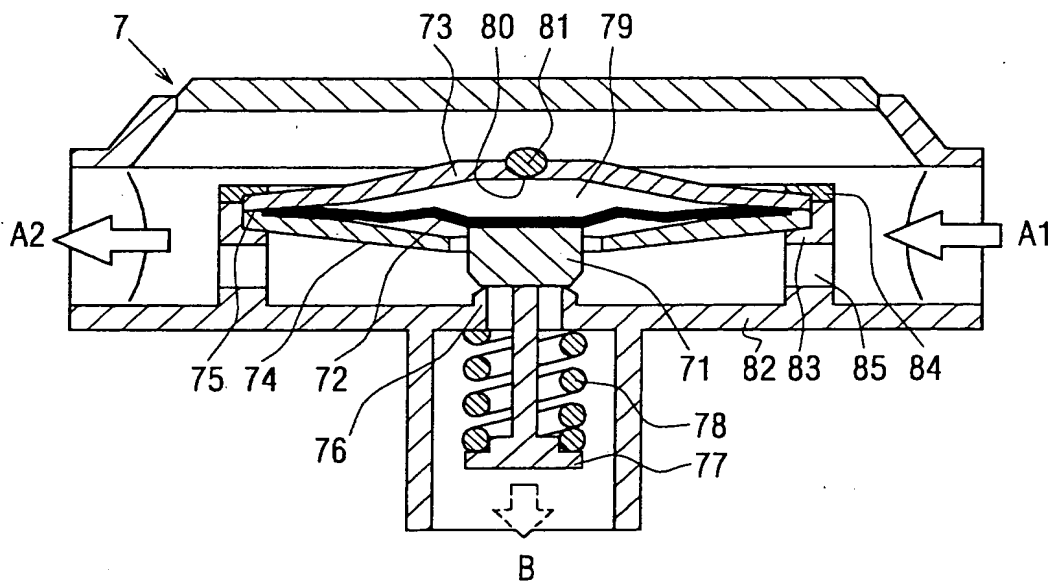


FIG. 2
【図2】



整理番号 = P S N 2 7 8

FIG. 3
 【図3】

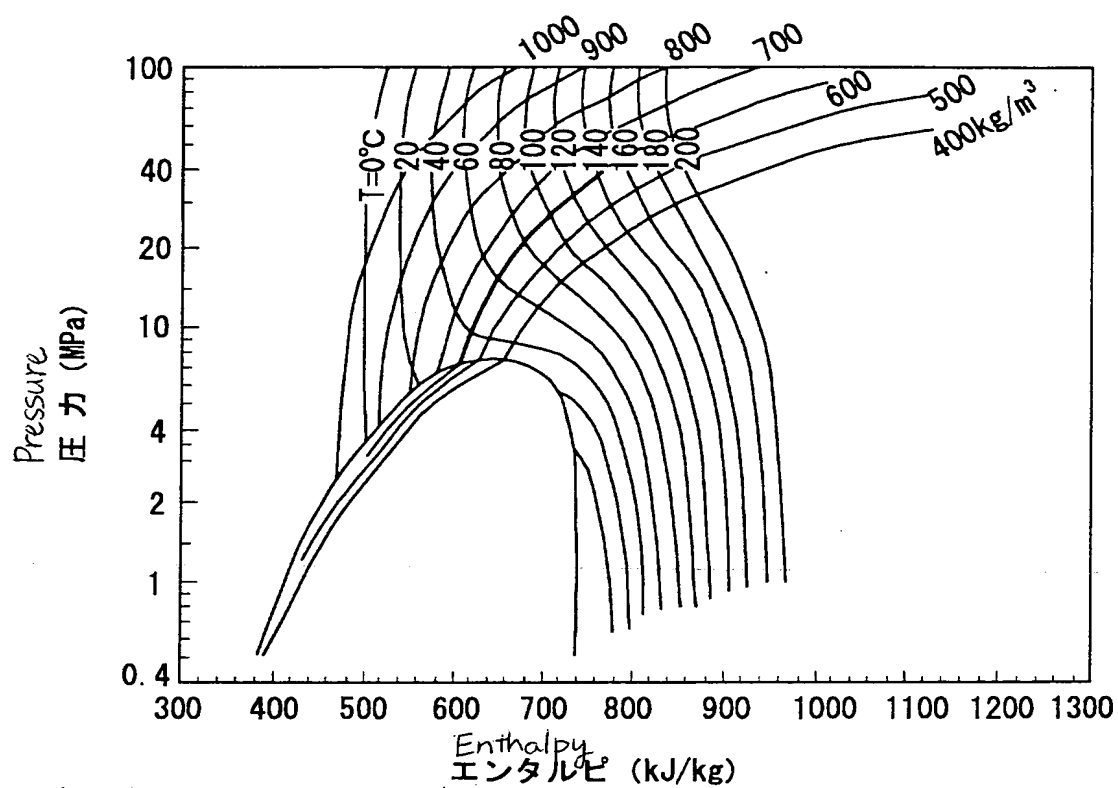
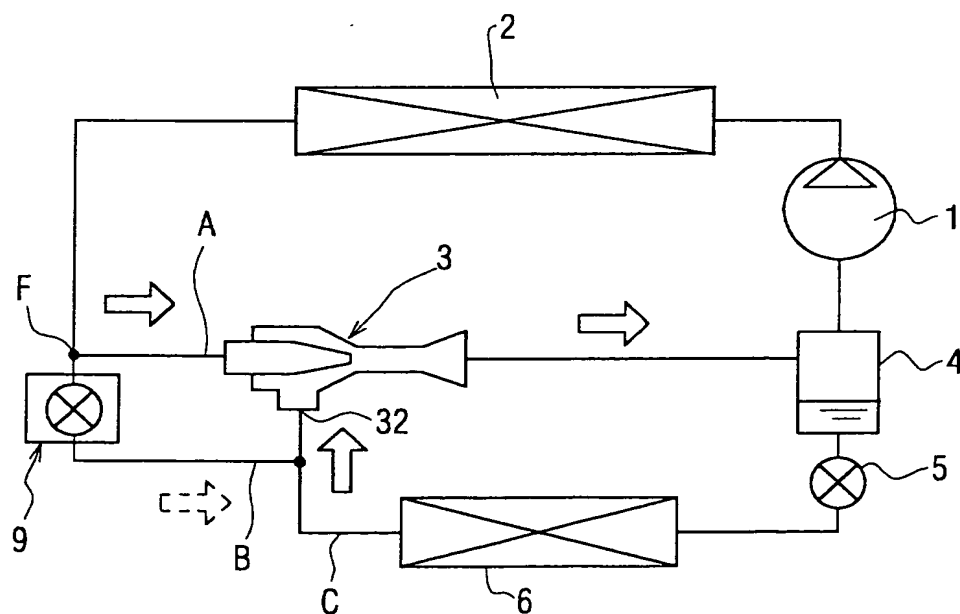


FIG. 4
 【図4】



整理番号 = P S N 2 7 8

FIG. 5
【図5】

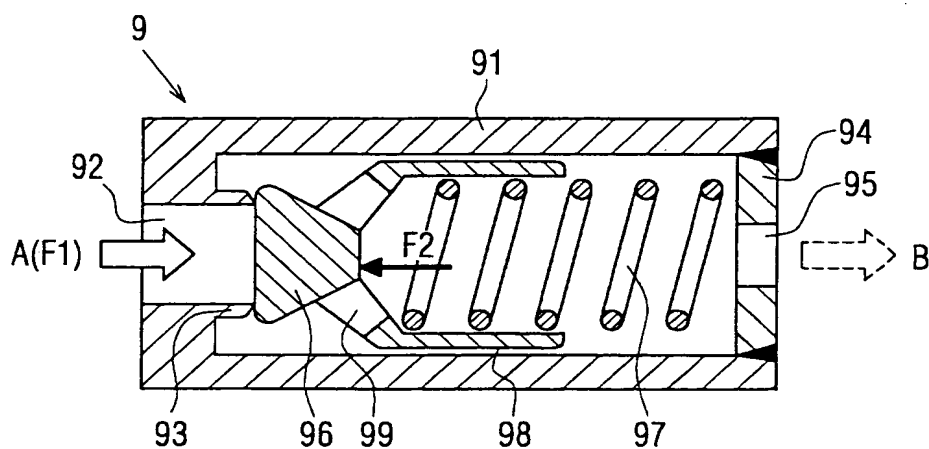
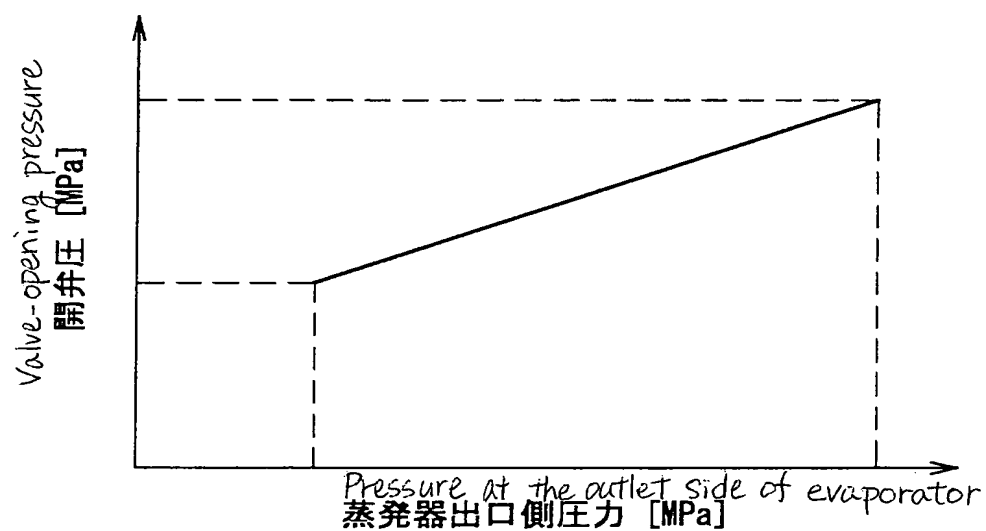


FIG. 6
【図6】



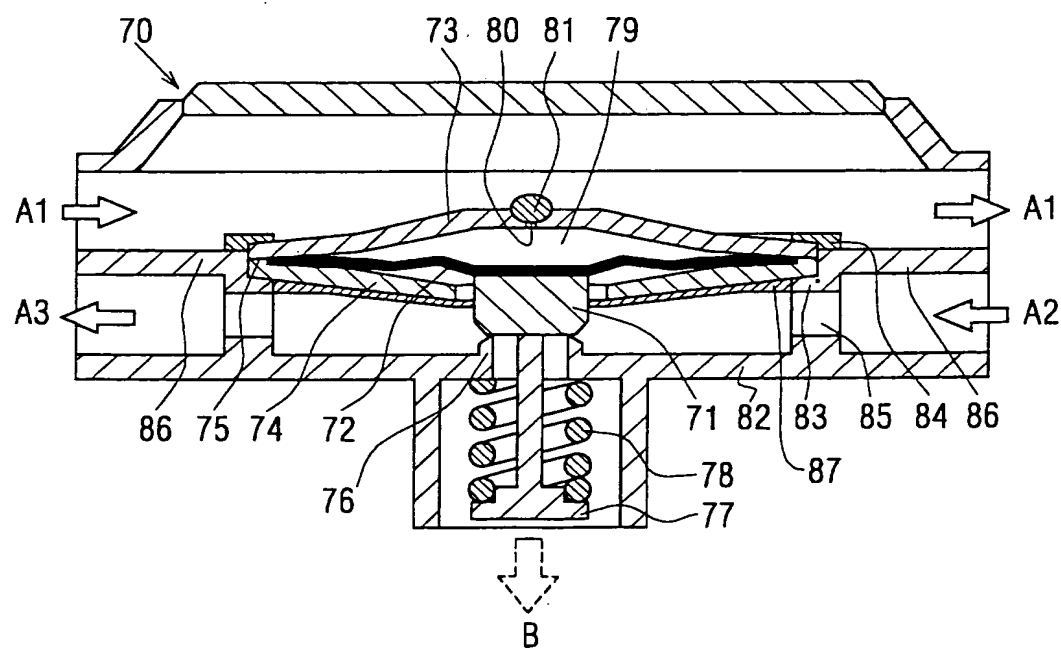
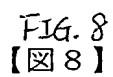


FIG. 9
【図9】

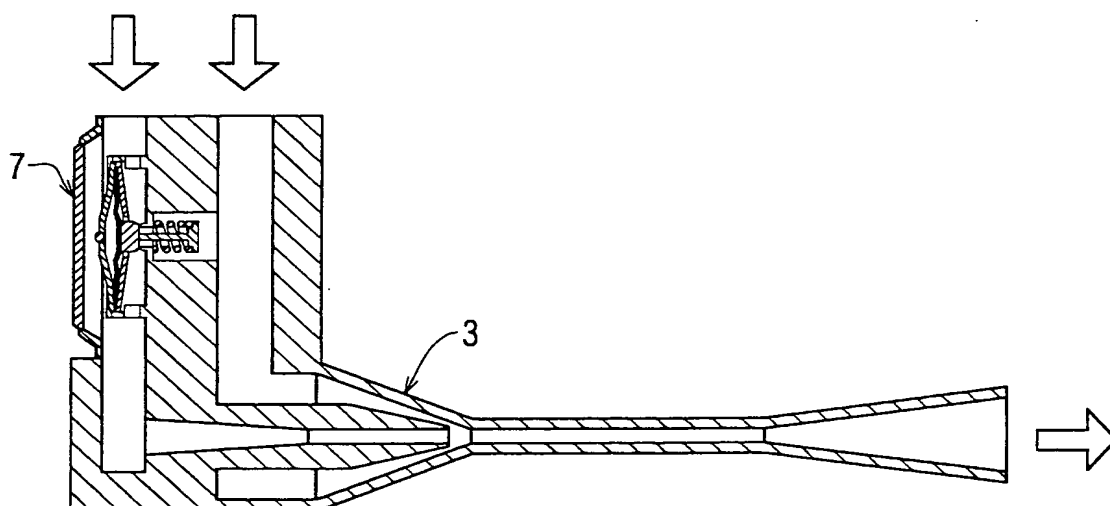
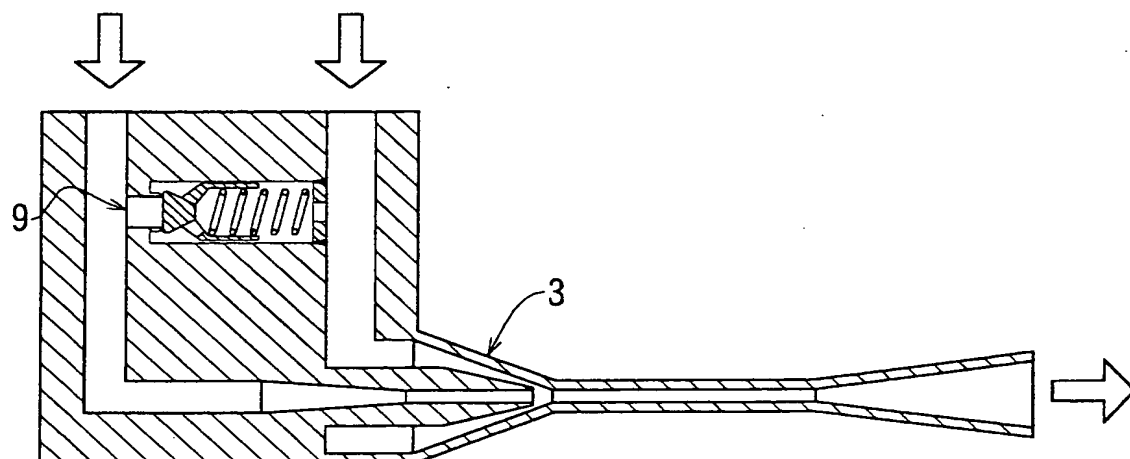


FIG. 10
【図10】



整理番号 = P S N 2 7 8

Fig. 11
 【図 11】

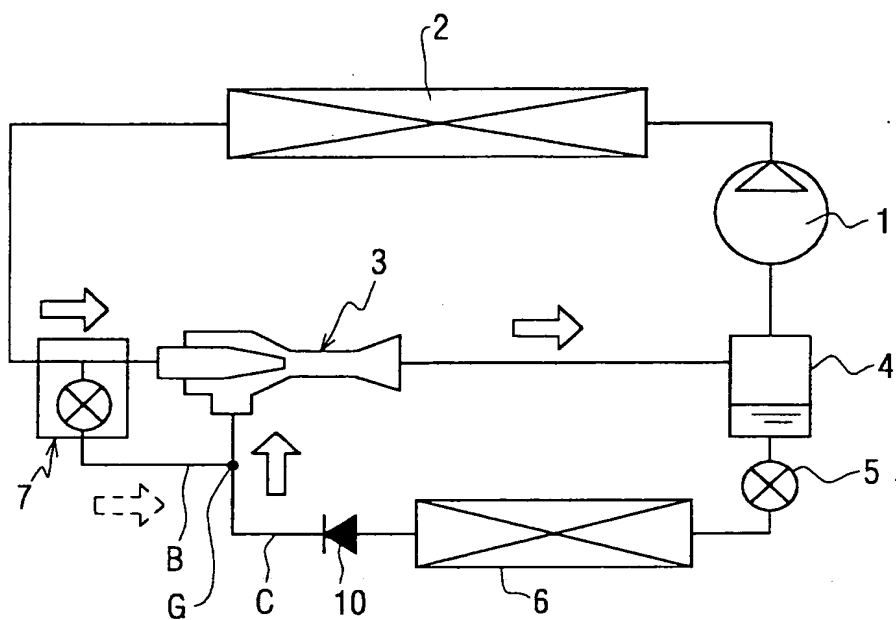
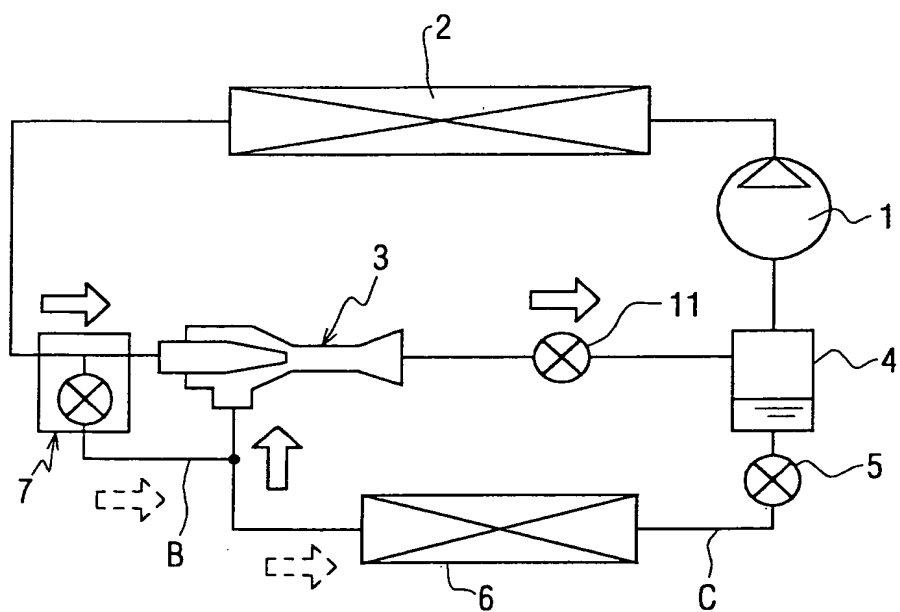


Fig. 12
 【図 12】



整理番号 = P S N 2 7 8

Fig. 13
【図 13】

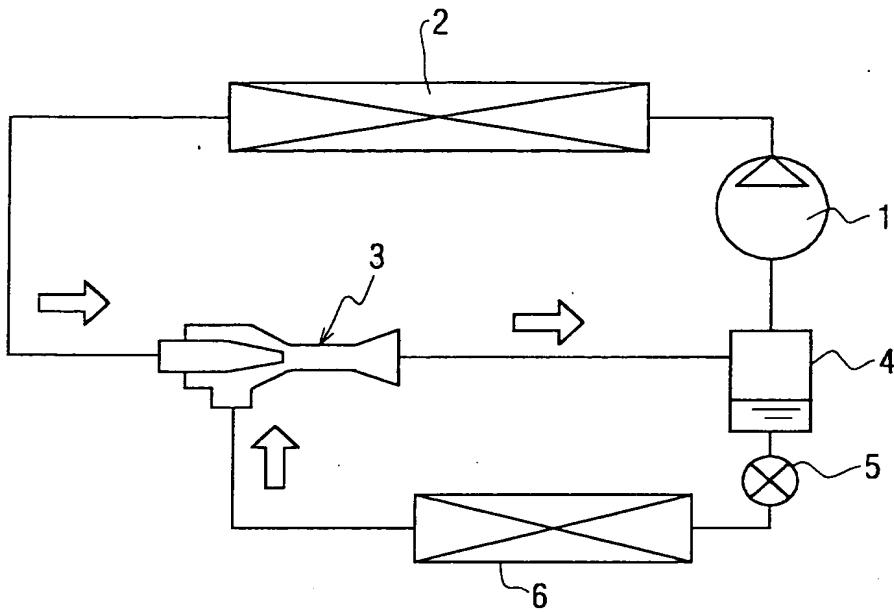
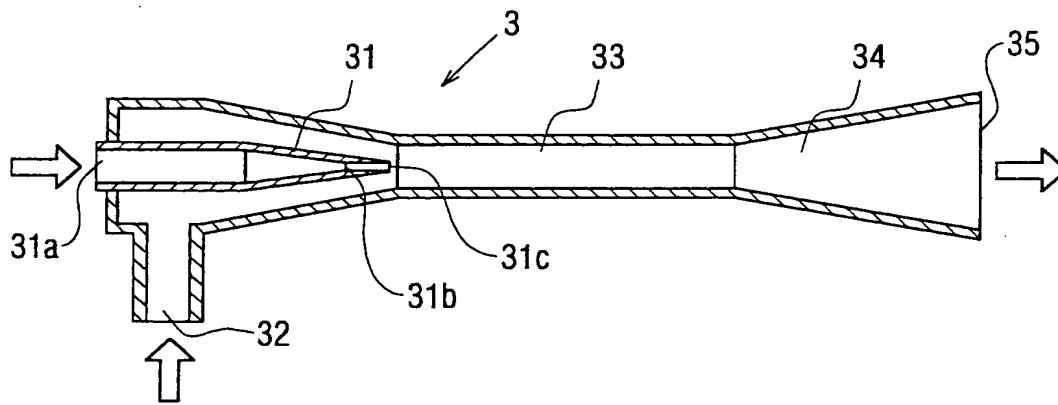


Fig. 14
【図 14】



[Designation of Document] ABSTRACT

[Abstract]

[Subject]

A refrigerant cycle apparatus, which prevents a pressure of a high-pressure refrigerant from being increased due to an increase of a refrigerant flow amount and improves cooling capacity in accordance with the increase of a refrigerant flow amount, is provided.

[Solution]

The bypass passage B through which a part of refrigerant from the radiator 2 flows from an upstream portion that is upstream of the high-pressure inlet portion 31a of the ejector 3 to the refrigerant passage C between the evaporator 6 and the suction port 32 is provided, and the control valve 7,9 and 70 is provided in the bypass passage B such that the control valve 7,9 and 70 is opened when refrigerant flowing from the radiator 2 meets the predetermined pressure condition so that refrigerant flows into the bypass passage B.

Accordingly, it can prevent the pressure of the high-pressure refrigerant from being excessively increased, and the refrigerant cycle operates stably. Besides, it can restrict the consumed power of the compressor 1 from being increased even when the refrigerant flow amount increases, and the efficiency of the refrigerant cycle can be improved.

[Selected Figure] FIG. 1